Annual warm-season grasses are often used as pasture, hay or silage crops throughout Missouri. Their rapid production of high-quality forage during late spring and summer makes them potentially important in summer grazing systems. Optimum yields require adequate moisture and nitrogen fertility. Warm-season annual grasses work well in rotation with row crops. High costs associated with annual establishment and high fertility requirements for maximum production make these crops a high-cost source of animal gain when compared with perennial forage crops.

Although many annual crops have been used for summer grazing, pearl millet (Pennisetum americanum) and sorghum-Sudan grass (Sorghum bicolor) hybrids are the most common. True Sudan grasses have been used extensively in the past, but they have fallen in use with the development of improved sorghum-Sudan grass hybrids. The Piper variety grass is a good choice of true Sudan grass because it has a lower prussic acid potential than other varieties. Crabgrass (Digitaria sanguinalis) is another annual species that can be used for summer pasture.

**Sorghum-Sudan grass hybrids**

Sorghum-Sudan grass hybrids are a leafy form of sorghum, or milo. They are formed by crossing forage sorghum types with leafy, true Sudan grasses. Forage sorghums are tall-growing, stemmy sorghums. Milo was developed by selecting for short types with large heads and a high harvest index.

There is little difference in yield among available hybrids, and most variation in yield can be attributed to differences in moisture availability. Commonly available hybrids include Summergrazer III, Green Graze, Dekalb SX-17 and Sweet Sunny Sue. Other available hybrids should perform similarly to those listed. Seed cost and availability should be used as a guide to selecting varieties.

Sorghum-Sudan grass hybrids are intolerant of soil acidity and should be planted only on land with a soil pH above 5.5. Sorghum-Sudan grass should be seeded during May at 30–35 pounds per acre if broadcast into a prepared seedbed or 20–25 pounds per acre when drilled in 7- to 15-inch rows. No-till establishment will work well if weed and sod competition are controlled with a burndown herbicide at seeding.

**Pearl millet**

Pearl millet can be seeded on more acidic sites than sorghum-Sudan grass hybrids and is somewhat more drought tolerant. Other millets, such as proso, foxtail or German, are less productive than pearl millet but are often used in silage or hay mixtures. They can be used for grazing, but low productivity and a shorter grazing season make them a poorer choice than pearl millet.

Pearl millet is typically drilled at 15 pounds per acre or broadcast into a prepared seedbed at 20–30 pounds per acre from May 1 through the middle of June. The major factor limiting the time of establishment after mid-June is the availability of moisture. Therefore, seeding before the beginning of summer is recommended because of the decreasing probability of rainfall as summer progresses. Widely available hybrids include Tifleaf I, Tifleaf II, Mil-Hy-300 and Sunny State. Again, little difference has been observed among pearl millet hybrids over many years of testing in several states, so any available hybrid should suffice. Pearl millet can be seeded on sites with lower water-holding capacity because of its better drought tolerance, while sorghum-Sudan grass hybrids will perform better on sites with a good supply of moisture.

**Crabgrass**

Although commonly considered a weed, crabgrass can provide high-quality summer forage and grazing. Managed properly, this annual grass can persist as a perennial through natural reseeding. To ensure natural reseeding, the ground should be lightly scarified with a disk or harrow in late April or early May to provide adequate soil-seed contact. An application of 40 pounds of nitrogen per acre will speed development of a stand. An additional 60 pounds of nitrogen per acre after establishment or following the first grazing should maintain growth of high-quality forage throughout the summer.

Total productivity of crabgrass will be determined by the availability of moisture. Crabgrass can
easily be double-cropped behind cool-season cereal pastures to produce 3,000–5,000 pounds of dry matter per acre in a season. When planted as a single crop with good growing conditions and adequate moisture, crabgrass can yield 4,000–8,000 pounds of dry matter per acre. The recent release of an improved crabgrass cultivar, Red River, by the Noble Foundation in Oklahoma has resulted in stable yields of 8,000–10,000 pounds of dry matter per acre.

Animals perform best on crabgrass pasture if it is grazed rotationally. This allows the producer to keep the forage in a high-quality vegetative growth stage. Beef cattle have gained up to 2.25 pounds per day on good crabgrass pasture and have repeatedly gained 0.2 pound per day more on crabgrass than on Bermudagrass.

**Harvest management**

Hay curing is difficult with either pearl millet or sorghum-Sudan grass because of their large stem size. It is imperative that a mower-conditioner with a crimper be used to crush the stems to speed drying. Recent hay-feeding trials at the Southwest Missouri Center indicated that properly supplemented animals could gain at 1.6–1.8 pounds per day on sorghum-Sudan grass and pearl millet. In this trial, digestibility of sorghum-Sudan grass averaged 86 percent, while pearl millet averaged 82 percent at harvest. The crude protein content of these grasses falls rapidly after they reach a height of 36 inches and heads begin to emerge. Crude protein content can easily be reduced from 12–14 percent in the vegetative growth stages to 6–7 percent when the grasses reach the dough stage of seed development.

Sorghum-Sudan grass hybrids can produce 4 to 8 tons of forage per acre when harvested to a 6- to 10-inch stubble. This grass should be harvested each time the accumulated growth reaches a height of 24–36 inches. Maximum yield of sorghum-Sudan grass hybrids is obtained if stubble height is maintained at 10 inches to allow for regrowth to originate from terminal buds rather than from buds at the base of the plant. Allowing forage to accumulate above 24 inches will result in stemmy, lower-quality forage.

Harvest management for pearl millet is much the same as for sorghum-Sudan grass hybrids as listed above, except that millets are more dependent on terminal buds for regrowth. This means that pearl millet must be cut to a higher stubble height than sorghum-Sudan grasses to ensure maximum yields. Pearl millet generally regrows more slowly than sorghum-Sudan grass hybrids, and the rate of regrowth can be greatly reduced by cool weather.

Key harvest suggestions include the following:

- Do not attempt to make hay without using a mower-conditioner.
- It is impossible to overcrush sorghum-Sudan grass and pearl millet stems.
- Use more roller pressure than is used on conventional hays and drive slowly in low gear.
- Do not windrow until all plants on the top of the swath are dry enough to bale (15–18 percent moisture).

Because of difficulties encountered with hay curing and the ability to obtain rapid production of forage, grazing is the best way to make use of these highly productive forage crops. Grazing trials conducted at the Southwest Missouri Center in the late 1960s and early 1970s indicated that these forages will support average daily gains (ADGs) of 1.4–1.7 pounds per day over a 90-day grazing season from June through August. Relay planting schemes have produced three-year mean ADGs of 1.7 pounds per day for weaned calves from May through September on pearl millet and sorghum-Sudan grass in Louisiana. Pasture establishment was staggered at 10-day intervals to ensure that immature forage was available throughout the summer. This was made possible through the use of irrigation to ensure that adequate soil moisture was available to support establishment.

**Soil fertility**

Soils to be planted to pearl millet and sorghum-Sudan grass should be tested before establishing a crop and should be fertilized with phosphorus and potassium according to test recommendations. Both these forages respond well to nitrogen fertilization and should receive 60 to 90 pounds of nitrogen per acre at establishment. Phosphorus and potassium should be applied according to the results of the soil test so that available levels of these nutrients are in at least the medium range. Pearl millet yield has responded to applied nitrogen up to a maximum yield of 5.5 tons of dry matter per acre at 400 pounds of nitrogen per acre. Best results are obtained by splitting nitrogen applications such that part of the nitrogen is applied when the crop is established and another 40 to 60 pounds per acre are applied after the first grazing. This practice improves the efficiency of using nitrogen fertilizer, provides more even forage production, and reduces the potential for nitrate toxicity due to overfertilization. Care must be taken with these forages to avoid nitrate toxicity. Excessive nitrogen fertilization is the key cause of nitrate toxicity.

**Livestock toxicities**

Heavy nitrogen fertilization followed by drought is the most common situation that causes nitrate accumulation in forage. Shading and cool, cloudy weather can also contribute to this problem. These environmental conditions result in nitrate accumulation because growth is limited while nitrate uptake contin-
ues. In cattle, nitrates are reduced to nitrite in the rumen. Nitrites are toxic to livestock because they interfere with the ability of blood to carry oxygen.

The rate of nitrate incorporation in plants is regulated by the nitrate reductase enzyme. Molybdenum is a key part of nitrate reductase. If plants are deficient in molybdenum, nitrate reduction is inhibited, potentially resulting in nitrate toxicity. The availability of molybdenum to plants is determined by soil acidity. Liming to desirable pH levels of 5.5–6.0 is usually sufficient to overcome molybdenum deficiency and alleviate this potential cause of nitrate toxicity. Nitrates are typically concentrated in the lower portion of the stem, so care should be taken to keep animals from consuming large amounts of the lower part of the stalk of these forages when nitrate concentrations may be high.

If plants contain more than 1.5 percent, or 15,000 parts per million (ppm), nitrate, they should be considered toxic to livestock. Nitrates will persist in harvested hay since they do not break down during the curing process. If nitrate accumulation is suspected, forage should be tested before feeding. Pregnant and young animals are particularly sensitive to nitrate toxicity. Care should be taken when feeding forages containing greater than 0.25 percent nitrate (2,500 ppm) as a percentage of dry matter to these animals. Forages containing 0.25–0.5 percent of dry matter as nitrate should make up no more than one-fourth of the total ration (Table 1). Forages with 0.5–1.5 percent nitrate should make up no more than one-fourth of the total ration, and livestock should receive supplemental energy, minerals and vitamin A.

Another potential toxicity problem with these forages is prussic acid, or cyanide poisoning. Sorghum-Sudan grass hybrids have the potential to develop toxic levels of prussic acid, particularly following drought stress, frost, or immediately after clipping. Highest concentrations are contained in new growth or regrowth, particularly after tissue damage. Pearl millet does not have the potential to develop prussic acid. Sorghum-Sudan grasses derived from Piper-type Sudan grass also have low prussic acid potential.

Unlike nitrates, which are persistent, prussic acid disappears during the hay curing or ensiling process. When regrowth occurs following drought or frost, grazing should be avoided for 14 days to allow prussic acid to dissipate. It is the young, fast-growing regrowth tissue following these stresses that typically contains potentially dangerous levels of prussic acid. Prussic acid is formed from cyanogenic glycosides present in certain plant species following periods of stress. Sorghums contain the glycoside dhurrin. When the sorghum plant is injured, enzymes that convert glycosides to sugar and prussic acid (HCN) are released.

Levels of HCN greater than 2 mg/kg (2 ppm) of dry plant tissue are considered potentially dangerous. Prussic acid is readily absorbed into the bloodstream and causes its toxic effect by blocking normal cellular respiration in the animal.

Prussic acid can be detected through the use of picrate strips. Filter paper that has been treated with a solution of picric acid and allowed to dry are suspended in a test tube over a sample of plant material that has been treated with a few drops of chloroform. The test tube is then incubated for several hours. If HCN is present, the yellow sodium picrate paper will turn increasingly red in direct proportion to HCN concentration.

### Key points in warm-season annual grass management

1. Warm-season annuals should be seeded when soil temperatures reach 55–60 degrees F in late spring while available moisture is still high.

2. Before the forage crop is established, phosphorus and potassium fertilizer should be applied according to soil tests.

### Table 1. Warning levels for forage nitrate content.

<table>
<thead>
<tr>
<th>Nitrate concentration</th>
<th>% ppm</th>
<th>Forage status</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–0.25</td>
<td>0–2,500</td>
<td>SAFE</td>
<td>Forage is generally safe to feed at these levels to all classes of livestock.</td>
</tr>
<tr>
<td>0.25–0.50</td>
<td>2,500–5,000</td>
<td>CAUTION</td>
<td>Forage with this nitrate (NO₃⁻) content can cause a problem with pregnant and young animals. Do not feed forage with nitrate levels this high in combination with nonprotein nitrogen supplements and limit forage with NO₃⁻ levels this high to one-half of total ration.</td>
</tr>
<tr>
<td>0.50–1.5</td>
<td>5,000–15,000</td>
<td>DANGER</td>
<td>Limit forage with this NO₃ level to one-fourth of total ration. Should supplement forage of this type with energy, minerals and vitamin A.</td>
</tr>
<tr>
<td>Over 1.5</td>
<td>Over 15,000</td>
<td>TOXIC</td>
<td>Forage with this NO₃ level or higher is toxic and should not be fed under any circumstance. If forage with this NO₃ concentration must be fed, it should be mixed with other feed and make up no more than 15% of the total ration.</td>
</tr>
</tbody>
</table>
3. Pearl millet should be used in preference to sorghum-Sudan grass on droughty, more acidic sites.

4. Nitrogen should be applied at 60 to 90 pounds per acre at establishment with additional applications of 40 to 60 pounds of nitrogen per acre after each grazing or harvest to obtain maximum yields.

5. Yield distribution of warm-season annual grasses can be extended by relay planting if adequate soil moisture is available for summer establishment.

6. For optimum production, pearl millet and sorghum-Sudan grass should be harvested to a 10-inch stubble each time growth accumulates to a height of 24 to 36 inches.

7. When grazed, annual grasses are best used with a rotational stocking scheme that leaves sufficient stubble and allows adequate rest between grazing periods to support regrowth.

8. Forage should not be harvested or grazed following prolonged periods of drought or cloudy weather, particularly when heavily fertilized with nitrogen, without prior testing for nitrate content. Forage containing more than 1.5 percent nitrate should not be fed. Consumption of forages containing greater than 0.5 percent, or 5,000 ppm, nitrate should be limited to no more than one-fourth of the ration.

9. Grazing should be delayed 10–14 days on sorghums following initiation of recovery growth following frost or drought stress to avoid prussic acid poisoning. Prussic acid dissipates during hay curing or ensiling, so harvested forage should not present a problem.